



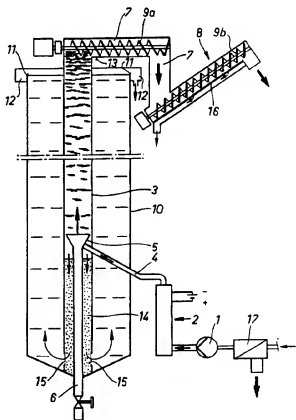
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/FI94/00518</p> <p>(22) International Filing Date: 18 November 1994 (18.11.94)</p> <p>(71) Applicant (for all designated States except US): HLS-ELEKTROAUTOMATIikka OY [FI/FI]; Konalantie 6-8 A, FIN-00370 Helsinki (FI).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): SUOMINEN, Hannu, L. [FI/FI]; Kotitorpantie 11, FIN-00690 Helsinki (FI).</p> <p>(74) Agent: LEITZINGER OY; Ruoholahdenkatu 8, FIN-00180 Helsinki (FI).</p>		<p>(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ).</p> <p><b>Published</b> With international search report. In English translation (filed in Finnish).</p>

(54) Title: FLOCK SEPARATING APPARATUS

## (57) Abstract

The invention relates to a flock separating apparatus, comprising an electrolytic cell (2) fitted with iron electrodes and a separating tank (3), wherein the flock is carried upwards by a hydrogen gas produced in electrolysis. The separating tank (3) comprises a substantially vertical pipe having a length which is at least 10 times, preferably at least 15-20 times more than its diameter.



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Flock separating apparatus.

- The present invention relates to a flock separating apparatus for use in sewage or sludge treatment, comprising an electrolytic cell and a separating tank, into which the flock developed in the electrolytic cell is delivered and in which the flock rises up through the action of a gas produced in electrolysis.
- 10 The treatment or purification of sewage and industrial process waters is conventionally (e.g. WO 89/06161) carried out by using flock separating tanks with air blown therein, so that the rising air bubbles carry the lighter solids to the surface as flock which can be removed. For example, the
- 15 Patent publications US-4,673,494 and US-4,294,697 disclose such a combination of an electrolytic cell and a separating tank that the electrolytically produced flock can be brought up to the surface in the separating tank by means of a gas released in electrolysis. Such a combination does not allow
- 20 the use of optimal cell and tank structures and dimensions, resulting in a poor separation efficiency. The prior known flock separating tanks are relatively shallow and have been aimed at a relatively large surface area.
- 25 An object of the invention is to provide an improved flock separating apparatus, wherein the flock rising speed and a resulting separation efficiency have been substantially increased when compared to the prior known equipment.
- 30 This object is achieved according to the invention in such a manner that the separating tank comprises a substantially vertical pipe, separated from an electrolytic cell and having a length which is at least 10 times, preferably at least 15 times more than its diameter, and that a feed or
- 35 supply pipe extending from the electrolytic cell to the separating pipe opens below the mid-point of the separating pipe, said separating pipe having its bottom end connected

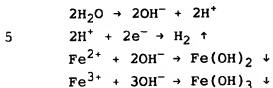
to a treated-water receiving and discharge tank and its top end rising above the surface level of said receiving and discharge tank.

- 5 Thus, the essential point in the invention is that a hydrogen gas produced in electrolysis is used for carrying the flock up in a narrow pipe with a high hydrostatic pressure and a high flow rate. Because of a high flow rate, the hydrogen gas adhered to flock particles does not have enough  
10 time to separate and, thus, the hydrostatic pressure in a high separating space produces a high rising speed for flock particles. On the other hand, the receiving and discharge tank with a sufficiently large surface area makes sure, according to the principle of communicating vessels, that  
15 the water contained in the separating pipe does not pursue a high rising speed and comes virtually to a halt at the water level of said receiving and discharge tank. Thus, the discharging flock carries along a minimal amount of water.
- 20 Although the bottom end of the separating pipe could open directly within the opening area of the supply pipe, the separating pipe can be extended downwards e.g. for positioning a sand filter in such a manner that typically about  $1/2 - 1/8$  of the separating pipe length is located below the  
25 supply pipe opening area.

The invention will now be described in more detail by way of an exemplary embodiment with reference made to the accompanying drawing, which shows a flock separating apparatus of  
30 the invention in a schematic vertical section.

The water or sludge subjected to a purification treatment is delivered through a coarse matter separator 17 and supplied by a pump 1 through an electrolytic cell 2 into a separating  
35 pipe 3. The cell 2 is provided e.g. with iron electrodes for passing therebetween the water or sludge to be treated. The

electrodes are supplied with a direct current, the cell being subjected e.g. to the following reactions:



- 10       The developing hydrogen gas adheres to ferro- and ferrihydroxide deposits, which are in turn producing a web or mesh structure for trapping solid impurities. This way, the solid matter flocculates and the flock-adhered hydrogen gas makes the flock lighter than water.
- 15       Naturally, the iron electrodes can be replaced with other metal electrodes as well. In addition or instead of hydrogen, the electrolysis may produce other gases as well depending on a liquid to be treated.
- 20       The supply pipe 4 opens into a cone 5 included in the separating pipe 3 and provided at its bottom end with a pipe 6 for collecting and removing heavy objects, such as small rocks. The flock particles begin to rise from the cone 5 upwards in the pipe 3 at quite a high climbing speed. At the
- 25       top end of said pipe 3 the flock particles pack into a froth-like flock deposit which is forced by a conveyor screw 9a into a flock discharge pipe 7. The pipe 7 carries the flock to a solids separator 8, such as e.g. a filter web, a screw press, a separator, a centrifuge or a like. In the
- 30       illustrated case, the separator 8 includes a chute-like filter web 16 and a conveyor screw 9b on top of it. The solid matter can be carried e.g. to a compostster and the liquid can be returned back to the intake side of the pump 1.
- 35       In the illustrated case, the separating pipe 3 extends also downwards from the cone 5 and, thus, it can be fitted with a

sand filter 14. The treated water has a passage through ports 15 into a receiving and discharge tank 10 having a surface area which is multiple compared to that of the separating pipe 3. By virtue of this, the climbing speed of water in the separating pipe 3 decelerates in relation to the flock climbing speed for a further improved separation efficiency. In some cases, the tank 10 may simultaneously serve as a storage bin for a liquid to be treated.

Between the inlet of the supply pipe 4 and the ports 15 said separating pipe 3 experiences a flow downwards, the flow rate corresponding to a runoff over an edge 11 into a discharge chute 12. The section of the pipe 3 located below the cone 5 can be replaced with a filter cloth bag for a simpler construction.

The height difference between the overflow edge 11 and a flock discharge edge 13 included in the receiving and discharge tank 10 can be made adjustable e.g. by providing the pipe 3 with a telescopic top end. By adjusting the top end of the pipe 3 (and the pipe 7) downwards it is possible to receive wetter flock more quickly. Thus, the overflow edge 11 must be located slightly below the level of the flock discharge edge 13 but a substantial distance above the inlet of the supply pipe 4. Since the pipes 10 and 3 operate on the principle of communicating vessels, the height difference therebetween must be adjusted or balanced in such a manner that both experience overflow and the height difference is caused or determined by the fact that the flock contained in said separating pipe 3 is lighter than water as a result of the hydrogen gas adhered thereto. Thus, the overflow equilibrium for communicating vessels is achieved by means of vessels having different heights.

The top end of the separating pipe 3 can be provided with a duct for the discharge of hydrogen gas. In major plants, the hydrogen gas can be recovered. It is also possible to recy-

cle the hydrogen gas back into the separating pipe 3 below the cone 5. Of course, it is possible to supply compressed air to the bottom end of the pipe 3 or to include a sand filter 14 in the bottom end of the pipe 3 below the cone 5.

- 5 The necessity of these extra arrangements depends on an intended application. The invention can be exploited both in a small and a large scale operation. The possible large-scale applications include both industrial waste waters and community sewage. The possible smaller scale applications  
10 include e.g. agricultural farms.

- In major plants, it is possible to connect several pieces of such equipment in line e.g. such that the top ends of separating pipes 3 included in different pieces of equipment are  
15 connected to a common flock discharge pipe 7.

- The invention has already been practically tested in the purification treatment of liquid manure in a hog farm. Hence, it was found out that the great length of separating  
20 pipe 3 in relation to the diameter is a particularly critical factor in view of securing a sufficient climbing speed and separation efficiency. In addition, the large surface area of tank 10 in relation to the surface area of pipe 3 was found advantageous in that water separates effectively  
25 from flock instead of pursuing to rise into the flock discharge pipe 7.

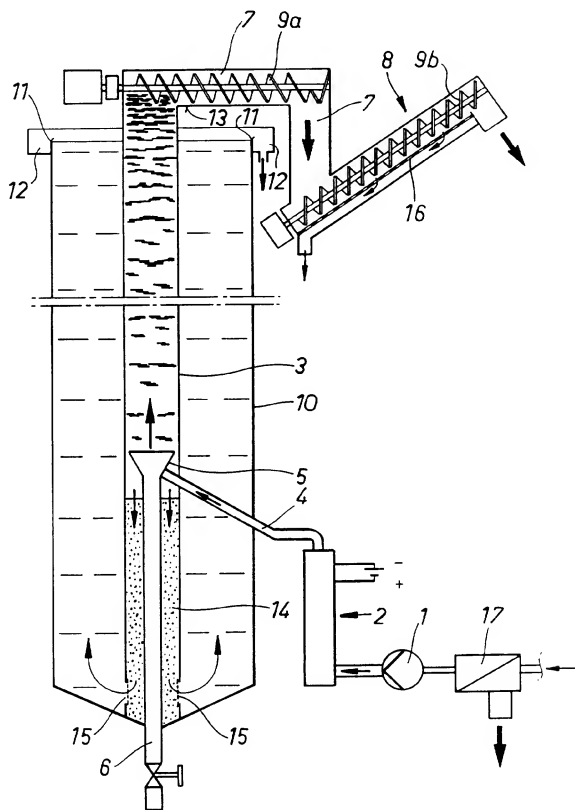
Claims

1. A flock separating apparatus for use in sewage or sludge treatment, comprising an electrolytic cell (2) and a separating tank (3), into which the flock developed in the electrolytic cell is delivered and in which the flock rises up through the action of a gas produced in electrolysis, c h a r a c t e r i z e d in that the separating tank (3) comprises a substantially vertical pipe, separated from the electrolytic cell (2) and having a length which is at least 10 times, preferably at least 15 times more than its diameter, and that a supply pipe (4) extending from the electrolytic cell (2) to the separating pipe (3) opens below the mid-point of the separating pipe (3), said separating pipe (3) having its bottom end connected to a treated-water receiving and discharge tank (10) and its top end rising above the surface level of said receiving and discharge tank (10).
2. An apparatus as set forth in claim 1, c h a r a c - t e r i z e d in that the separating pipe (3) has a diameter which is within the range of 100 - 500 mm as its length is within the range of 2000 - 10.000 mm.
3. An apparatus as set forth in claim 1 or 2, c h a r a c - t e r i z e d in that said supply pipe (4) opens into the bottom end of the separating pipe (3) or into a location along the separating pipe (3) whose distance from the bottom end of the separating pipe (3) is approximately  $1/2 - 1/8$  of the length of the separating pipe (3), and that the top end of the separating pipe (3) has a height which is adjustable.
4. An apparatus as set forth in any of claims 1-3, c h a r - a c t e r i z e d in that the top end of the separating pipe (3) is provided with a flock discharge edge (13) located on a higher level than a surface level (11) in the receiving and discharge tank.



5. An apparatus as set forth in any of claims 1-4, c h a r -  
a c t e r i z e d in that the treated-water receiving and  
discharge tank (10) surrounds the separating tank (3) and  
has a surface area which is substantially larger than the  
5 cross-sectional area of the separating pipe (3).
6. An apparatus as set forth in claim 5, c h a r a c -  
t e r i z e d in that the treated-water receiving and dis-  
charge tank (10) comprises a storage bin for sewage or  
10 sludge to be treated, the treated water being led into said  
bin.
7. An apparatus as set forth in any of the preceding claims,  
c h a r a c t e r i z e d in that the separating pipe (3)  
15 has its bottom end fitted with a sand filter (14).
8. An apparatus as set forth in any of the preceding claims,  
c h a r a c t e r i z e d in that said supply pipe (4) is  
connected to a cone (5) included in the separating pipe (3),  
20 the bottom of said cone opening into a discharge pipe (6)  
for heavy objects.
9. An apparatus as set forth in any of the preceding claims,  
c h a r a c t e r i z e d in that the flock discharge edge  
25 (13) is connected to a substantially horizontal flock dis-  
charge pipe (7) provided with a screw conveyor (9a), and  
that the flock discharge pipe (7) is connected to a solids  
separator (8) for removing liquid from the flock.
- 30 10. An apparatus as set forth in claim 1, c h a r a c -  
t e r i z e d in that the section of the separating pipe (3)  
located below the opening point of the supply pipe (4) is  
replaced with a filter cloth sleeve or bag.

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 94/00518

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C02F 1/465

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4834872 (HORST OVERATH), 30 May 1989 (30.05.89), column 3, line 28 - line 34; column 4, line 29 - line 45, figure 1 --	1-10
Y	WO, A1, 9304003 (IWATECH KONRADT GMBH), 4 March 1993 (04.03.93) --	1-10
A	JOURNAL WPCF, Volume 54, No 12, December 1982, John R. Bratby, "Treatment of raw wastewater overflows by dissolved-air flotation" page 1558 - page 1565 --	1-10

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 1099396 (JOHN EDWARD ROTHWELL), 9 June 1914 (09.06.14)  --	1-10
A	Patent Abstracts of Japan, Vol 9, No 260, C-309, abstract of JP, A, 60-110389 (YASUKAWA DENKI SEISAKUSHO K.K.), 15 June 1985 (15.06.85)  -- -----	1-10

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

03/05/95

International application No.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4834872	30/05/89	AU-A- 8281887 DE-A- 3643931 EP-A,B- 0274083 FI-C- 90857 JP-A- 63166498	23/06/88 07/07/88 13/07/88 11/04/94 09/07/88
WO-A1- 9304003	04/03/93	NONE	
US-A- 1099396	09/06/14	NONE	